Water Quality in Purification (Depuration) Systems

Guidance for Purification Plant Operators

The need for clean seawater
The use of clean seawater is vital to avoid contaminating your shellfish.

Turbid water can contain microbiological contamination attached to suspended particles causing the turbidity. Whilst this will not always be the case, unless specific testing is carried out to prove otherwise, it is safest to assume that turbid water is contaminated and therefore its use avoided. As well as potentially containing harmful microbes, turbid water may adversely affect UV disinfection performance. Seawater must pass through the UV disinfection process before coming into contact with shellfish in the tanks. After having passed through the UV system the seawater should be microbiologically clean.

Cefas has issued the following advice on a depuration seawater standard:

Turbidity: **<15 Nephelometric Turbidity Units (NTU)**
Microbiology: **<1 *E. coli* /100ml**

Obtaining clean seawater
Seawater used for depuration may be sourced or abstracted from the nearest convenient point to the purification plant e.g. in an estuary, river, harbour or creek. Location of abstraction points should be away from obvious sources of faecal contamination and chemical pollution or areas that are prone to frequent disturbance of the sea/river bed. If in doubt Cefas are happy to offer advice on the suitability of proposed abstraction points.


Avoid taking water from areas close to any outlet pipes

Good practice when collecting seawater

- *Collect seawater at a time when there is minimal disturbance to the sea/river bed and ideally at high water to ensure that seawater is as clean as possible (contamination often comes from upstream sources so incoming seawater may have a beneficial dilution effect).*
- *Avoid collecting seawater after rainfall or other known potential pollution events. Rainfall can lead to reduced salinity making it unsuitable for use in depuration.*
- *Periodically test the water at the abstraction point to check that it remains of an acceptable quality; testing pre and post UV can confirm whether the UV is working effectively.*
- *If the water is turbid, hold for a period of around 12 hours (e.g. overnight) in a separate storage tank to enable the particulate matter to settle to the bottom of the tank. When transferring the settled water be careful to avoid disturbance of the settled debris. Settlement tanks should be easily cleanable and any debris should be discarded.*
- *In line-cartridge filters or sand filters may be used if long periods of settlement are not practical. Filters should be used in accordance with manufacturer's instructions. N.B. Filters may harbour potentially harmful micro-organisms along with other contaminants and so regular cleaning is essential.*

Role of UV in ensuring clean seawater
In order to ensure microbiologically clean seawater it is a requirement in England and Wales for purification systems to be filled via the operational UV (and/or ozone unit where applicable). Where this is not possible, seawater may be recirculated for a period of time sufficient to ensure that all the water has passed through the UV unit before it is allowed to come into contact with the shellfish. Seawater should be clear* as turbidity, even at quite low levels, may shield microbes from the disinfection effect of the UV light.

**Clean, clear seawater as it enters purification tanks (after passing through the UV unit) may occasionally suspend any residual dirt/sediment left on the surface of the shellfish after they have been cleaned (or perhaps contained within the shellfish themselves) and, in so doing, create slight turbidity in the water. Whilst not ideal, it is recognised that this may be unavoidable, particularly if shellfish have originated from muddy or silty areas, but the water should clear within an hour or so. The 42 hour cycle should start after the water has cleared.*

Brief history of UV in depuration
UV disinfection is the most commonly used form of water treatment on purification systems in England and Wales. A minimum dose of 10mJ/cm^2 (100J/m^2) has been the standard used in England and Wales since the 1980s.

A typical UV unit used on depuration systems in England and Wales

Modern depuration systems use sealed units consisting of a reaction chamber and a UV tube held within a quartz sleeve. The sleeve surrounds the UV tube and seawater passes between the sleeve and the outer wall of the UV reaction chamber (see figure 1 for typical cross section of a chamber). The quartz sleeve must be kept clean to allow the UV light to pass through unimpeded.

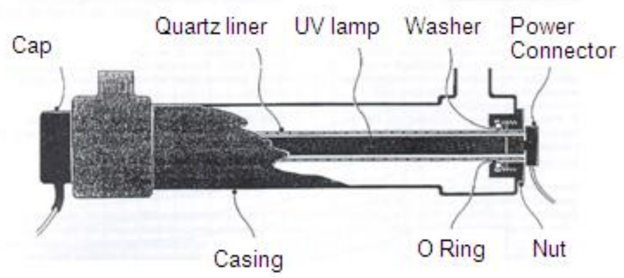

Figure 1 UV steriliser unit (adapted from Seafish technical report)

Applied dose

Applied dose (or 'fluence') is a measure often used to describe UV disinfection capacity. The dose applied depends on UV lamp strength and exposure time.

The higher the flow rate, the shorter the retention time (exposure) in the unit, therefore the smaller the dose received by the water and micro-organisms that it may contain. Flow rates set on Cefas Conditions of Approval are primarily intended to achieve the desired oxygenation levels but also take account of UV dosage to ensure that the minimum dose requirement (10mJ/cm^2) is achieved. For this reason, flow rates should not be changed significantly without prior consultation with Cefas.

As the lamp ages its strength will slowly diminish. Operators should consult their manufacturer's datasheets periodically to ensure that the life expectancy rating of their particular lamp does not change. Cefas use the manufacturer's rated time to reach 80% efficiency as the time at which a change of lamps is necessary.

Effect on potentially harmful micro-organisms

Relatively recent published work has highlighted the fact that the current 10mJ/cm^2 standard, whilst being relatively effective against bacteria, has little impact on viral pathogens.

To ensure that viruses are inactivated, an applied dose of at least 40 mJ/cm^2 (400 J/m^2) has been suggested as being necessary (Hoyer 1998). Such a dose may only achieve 90% reduction in virus levels (Nuanualsuwan et al 2002). As much as 600 mJ/cm^2 (6000 J/m^2) – over 10 times greater dose again - has been reported as being needed to achieve total inactivation of Hepatitis A (Bhattacharya et al, 2004).

A recent review (unpublished) by Cefas identified that the UV applied dose values delivered on a single pass through the UV unit under normal operating conditions by standard Seafish design depuration units exceeded the current minimum required in England and Wales (10mJ/cm^2) but generally fell short of the values identified above as being effective against viruses. Operators may therefore want to consider in their HACCP plans whether the disinfection arrangements on their systems are able to ensure that their shellfish are exposed only to clean seawater. If necessary, advice should be sought from Seafish or other suitable consultant to assist with this assessment.

One way to increase the UV dose on the initial filling of the system (and therefore to ensure that the purification cycle starts with clean seawater) at little or no additional cost is to reduce the flow rate through the UV unit as it enters the system for the first time. This option is not appropriate, however, during recirculation once the cycle has commenced as reducing the flow rate is likely to have an adverse impact on seawater dissolved oxygen levels.

Summary

- Only 'clean seawater' should be used in the depuration system.
- The legal definition of clean seawater (EC Regulation 852/2004) is open to interpretation.
- Cefas has issued advice to assist in this interpretation from the microbiological perspective (see values above for turbidity and *E. coli*).
- The source of any seawater used should carry no risk of contaminating the shellfish (including the risk from 'harmful substances' or toxic marine plankton).
- Further advice on issues relating to the statutory requirements for clean seawater and purification system operation is available by contacting Cefas Weymouth on 01305 206600. Technical advice relating to purification system design is available from www.Seafish.org

References

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